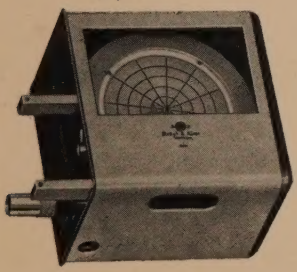
2370 . 2371

INSTRUCTIONS AND APPLICATIONS

Polar Diagram Recorder Type 2370
Turntable Type 2371



This instrument, coupled to the writing system of the level recorder, permits of a great variety of measurements of the directional characteristics of loudspeakers, microphones, wireless antennas, lighting equipment etc.

- Beat frequency oscillators
- Low frequency oscillators
- Deviation test bridges
- Strain gauge apparatus
- Frequency measuring bridges
- Distortion measuring bridges
- Heterodyne voltmeters
- Audio frequency spectrometers
- Frequency analyzers
- Level recorders, a. c. and d. c.
- Automatic frequency response recorders
- Automatic A. F. spectographs
- Logarithmic potentiometers
- Noise level potentiometers
- Recording paper
- Polar diagram recorders
- Vacuum tube voltmeters
- Wide range vacuum tube voltmeters
- Diode voltmeters
- D. C. voltmeters
- Megohmmeters
- Microphone amplifiers
- Impact sound generators
- Acoustic standing wave apparatus
- Artificial ears
- Condenser microphones
- Microphone calibration apparatus
- Vibration pick-ups
- Integration networks
- Rotary selectors
- Universal selectors
- Frequency response tracers
- Conductivity meters
- Electronic counters
- Counting rate meters
- Impulse generators
- Portable dose rate meters
- Portable counting rate meters
- G. M. tubes & accessories

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POLAR DIAGRAM RECORDER TYPE 2370 AND TURNTABLE TYPE 2371

The Polar Recorder attachment is constructed for mounting on Level Recorders type 2301 and type 2331, and the Automatic Frequency Response Recorder type 2310. With the help of the Polar Recorder it is possible to record polar diagrams showing, for example, the directional characteristics of microphones, loudspeakers, antennas, fluorescent light fittings, ultrasonic generators, hearing aids, ordinary radio sets and so on.

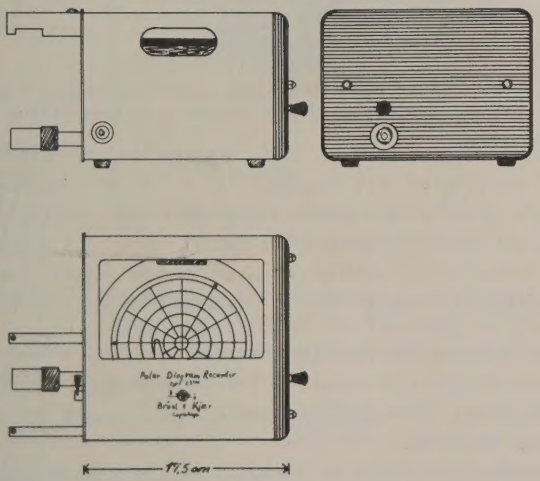


Fig. 1. Polar Diagram Recorder Type 2370.

The instrument (see diagram, fig. 1), mounted on the side of the Level Recorder, consists of a rotating disc on which the recording paper is placed. The scratcher in the Polar Diagram Apparatus is coupled mechanically to the moving system of the Recorder, so that the polar curve is recorded with the Level Recorder's driving apparatus, consisting of potentiometer, electronic amplifier and magnet system. The disc with recording paper is driven either from the

motor of the Level Recorder itself or from an external motor, as the coupling between the Level Recorder's motor and the Polar Diagram Recorder can be interrupted. Fig. 2 shows a photograph of the Recorder and accessories.

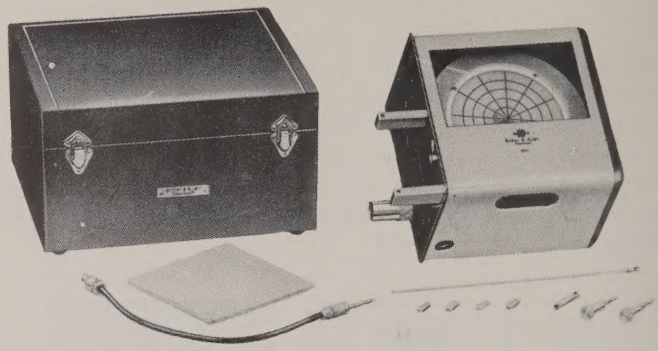


Fig. 2. Polar Diagram Recorder, case, recording paper, light cable, connecting rod, 4 magnets, coupling piece, fixing screws.

As auxiliary equipment to the Polar Diagram Recorder a Turntable has been constructed (see diagram, fig. 3), on which the measuring object, for example microphone, loudspeaker, radio-receiver, fluorescent light mounting, hearing aid and so on, can be placed and rotated synchronously with the paper on the Recorder. The Recorder and Turntable are coupled together mechanically by a flexible shaft.

The Polar Recorder has thus the same electrical specification as Level Recorder 2301, of which the most important points are:

Frequency Range: From 20-200.000 c/s.

Zero Level: Adjustable from 3-12 mV. The normal zero level is 10 mV.

Recording Speed: Variable in 9 steps from 700 to 50 db per second with the 50 db potentiometer.

Potentiometer: Potentiometers with 10, 25, 50 and 75 db range and a linear potentiometer are obtainable.

Accuracy:

75 db potentiometer:	± 1 db
50 " " :	± 1/2 db
25 " " :	± 0.3 db
10 " " :	± 0.2 db
linear " :	2%.

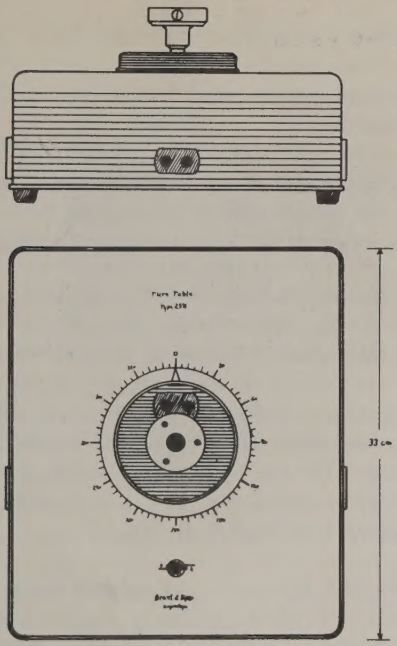


Fig. 3. Turntable type 2371.

Worm Drive: The ratio of the worm drive in both the Polar Recorder Apparatus and the Turntable is 1/180, i.e. one turn on the flexible shaft is exactly 2° on the record.

Time for One Revolution with Recorder Motor: 2.4 - 7.5 - 24 - 75 etc minutes.

Speed with Separate Motor: Any speed up to one revolution in 10 seconds.

Recording Paper: Dimensions 11.5 x 11.5 cm with preprinted polar diagram.
Writing length is 50 mm.

Type of Recording Paper: 1) Red or black paper covered with white wax.
2) Transparent paper covered with red wax for blue prints.

Mounting of Polar Diagram Recorder Type 2370

1. The two screws to the right of the gear case on the Level Recorder are removed.

2. The Recorder's writing paper is removed, and the paper holder lifted up. The little tubular lamp placed in the tube above the paper holder so as to illuminate the writing paper is removed.

3. The lighting cable from the Polar Recorder is inserted in the tube instead of the tubular lamp. One must be careful that the end of the lighting cable's contact sits firmly in the little spring which makes the contact at the other end of the tube. If this spring is pressed incorrectly a short-circuit to the case can arise. When the lighting cable is screwed in it is not possible to press the paper holder down on to the paper track, as the lighting cable connector strikes against the cover of the gear box. This is actually a protection against damage.

4. The small thin connecting rod which connects the Polar Recorder scratcher with the writing system in the Level Recorder is inserted carefully into the holes in the gear case. The little screw which holds the scratcher in the Level Recorder is loosened with a screwdriver, and the slot in the end of the connecting rod is pressed over the conically shaped screw. The screw is then set firm again, and the whole writing system is then guided to the left.

5. The Polar Recorder is now brought carefully into place and fastened above with the two screws which go down through the vertical supporting pieces, and below by means of the rotation nut which screws over the lowest axle-end in the Level Recorder. If the Polar Recorder is to be driven from the Level Recorder's motor one should beforehand have attached a small slotted coupling piece between the Level Recorder's axle and the Polar Recorder's worm gear axle.

None of these three connecting points should be tightened, before they are all held firmly.

6. Then connect the Polar Recorder's scratcher with the connecting rod mentioned under point 4 by carefully inserting the writing arm of the Polar Recorder in the socket on the connecting rod. Then move the writing system to the right, so that the Polar Recorder's sapphire point strikes the hub on the rotating table, making at the same time sure that the writing system in the Level Recorder strikes against the right-hand stop. Then firmly connect the thin connecting rod and Polar Recorder' s writing arm. One can now carefully move the writing system to the left and make sure that the Polar Recorder can write over the whole length of the paper. On reaching the limiting position on the left, both the parts in the Polar Recorder and the Level Recorder should strike at the same time.

7. The light cable should now be connected at the other end to the Polar Recorder, and when switching on the light for the Level Recorder, the lighting in the Polar Recorder should operate. When the switch on the Polar Recorder is turned to the left, the lamp above the rotating table should light, and when turned to the right the three lamps underneath the rotating table should light. The first position is used for recording paper type 2372, and the other position is used for recording paper type 2373, which is transparent and should therefore preferably have light coming from below.

8. The paper is inserted by first lifting the sapphire point from the rotating table's base with the lifting arm. The paper is carefully placed in position, so that it fits firmly over the table's hub. Small flat magnets are placed over the four corners, which hold the recording paper in its place. The table can be turned with the help of the fingers, as it is coupled to the worm drive with a friction coupling. It is thus very easy to quickly place the magnets on all four corners and adjust the paper to a given orientation. With the little handle on the left-hand side of the Polar Recorder the sapphire writing point can be lifted up or pressed down, thus interrupting or beginning the drawing of diagrams when desired. When the Polar Recorder is connected to the Level Recorder without paper being placed in the Polar Diagram Recorder, the sapphire point must be lifted so as not to damage the surface of the transparent rotating table. Fig. 4 is a photograph of the Polar Recorder connected to the Automatic Frequency Recorder type 2310.

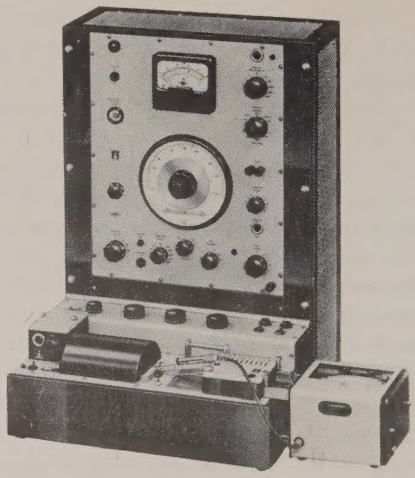


Fig. 4. Polar Recorder connected to the Automatic Frequency Recorder Type 2310.

9. Connection to Turntable type 2371 takes place simply by joining the flexible shaft between the Polar Recorder's right-hand side and the one side of the Turntable. If the Turntable is connected on the opposite side, it will rotate in the opposite direction. Thus the direction of rotation of the Turntable can be chosen so as to go with the direction of the paper diagram or against the direction of the paper diagram. As the same worm-gear drive ratio is found in both the Polar Diagram Recorder and the Turntable they will always rotate synchronously. If the Polar Recorder and the Turntable are both driven from the Level Recorder's motor, one is limited both as regards speed, as the greatest speed of rotation is one rotation per 2.4 minutes, and as regards the distance possible between the Polar Recorder and the Turntable, as one cannot have a particularly long cable because the motor in the Level Recorder is too weak to drive any considerable load.

Fig. 5 is a photograph of the Polar Recorder connected to the High Speed Level Recorder type 2301, with the Turntable type 2371 connected up.

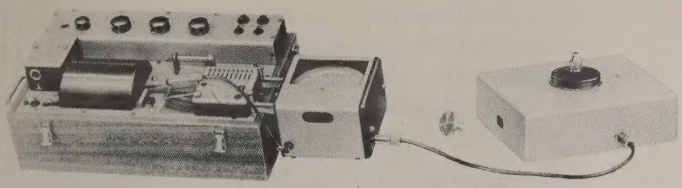


Fig. 5. Polar Recorder connected to the High Speed Level Recorder Type 2301, and the connection to the Turntable.

10. To have the possibility of larger distance between the Polar Recorder and the Turntable one is therefore recommended to insert an ordinary electric motor between the Polar Recorder and the Turntable as is indicated in fig. 6.

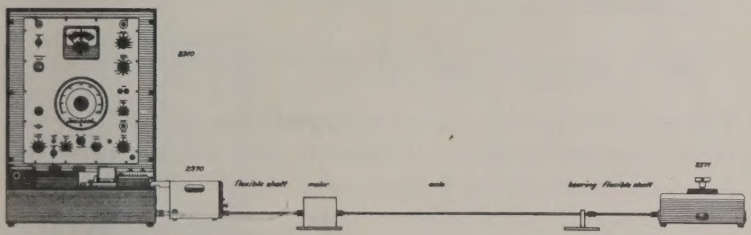


Fig. 6. Use of separate motor to drive Polar Recorder and Turntable.

This separate motor should have its axle extended at both ends and the motor is simply inserted somewhere between the connection from the Polar Recorder to the Turntable. An extra flexible shaft can be delivered to special order as well as those loose parts such as the end plugs, into which these flexible shafts normally screw. As a rule these can easily be placed on any kind of motor. It will be of great advantage to have the possibility for variation of the speed of rotation.

11. The Turntable is equipped with a chuck which either permits the fastening of a long rod, which is of interest for microphone measurements and the measuring of quite light hearing aids, small loudspeakers and so on, or can have a plate fastened to it with three screws, on which one can put heavier things, such as small radio receivers, large loudspeakers and such like.

With rather large distances between the Turntable and the Polar Recorder it is recommended that an electrical coupling should be used between them. One could for example as shown in fig. 7 couple in a pair of mag-slips or selsyns to take over the movement from the Polar Recorder to the Turntable.

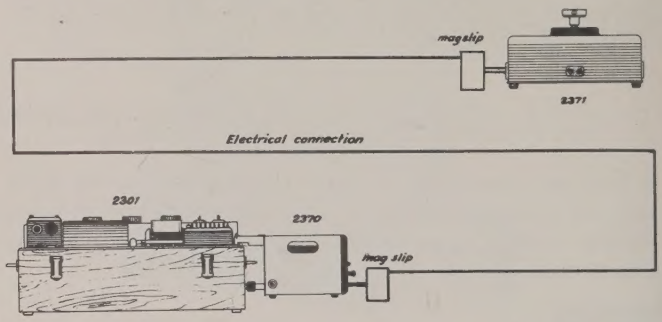


Fig. 7. Use of magslips or selsyns for synchronizing Polar Recorder and Turntable.

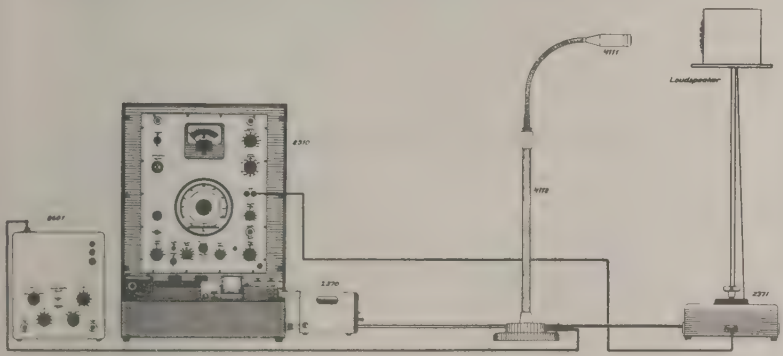
As there is no friction coupling on the Turntable it must first be set to the proper position by letting the motor run and then making use of the friction coupling in the Polar Recorder so as to obtain the proper position on the diagram paper. When the external motor is used, and the small coupling rod between the Level Recorder's gear axle and the Polar Recorder's worm drive has already been put in, one can, by pressing in a button on the right-hand side of the Polar Recorder, break the connection to the Level Recorder motor. When the button is pulled out, the Level Recorder motor will again drive the Polar Recorder's disc. It is thus permitted, if one wishes, to always have the small coupling rod in the worm drive axle inserted.

The Turntable is equipped with a set of rubbing contacts, which makes it possible to supply current to a loudspeaker, microphone, light armature and so on, without the risk of cables twisting when the Turntable turns, even though it should rotate many times. Connections for this cable are found on one of the short sides of the Turntable, and the pick-up points are found on the cylindrical plate which lies above the Turntable and rotates with it.

At the base of the main axle of the Turntable is a pressure bearing with ball bearings, so that it is possible to bring even rather heavy things on the Turntable. However, one must be careful not to put too big a torque on the axle, as in this case the rotating table will be too heavy to turn. One should also make sure that the objects have their centre of gravity placed axially on the Turntable.

Applications

Fig. 8 shows a typical measurement for the directional characteristics of a loudspeaker. The measurement is carried out normally by placing the loudspeaker in a sound-damped room and bringing the microphone in a fixed position in relation to the loudspeaker. The



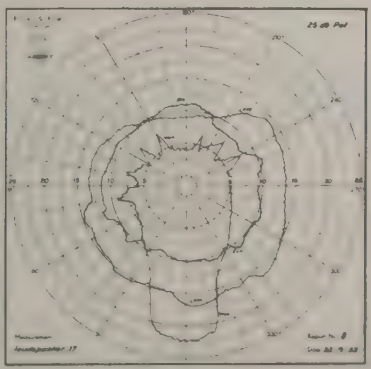


Fig. 8. Recording of directional characteristics of loudspeakers, with example of recording.

sound pressure will vary as the loudspeaker is rotated. If there are great differences in level in the loudspeaker's radiation diagram, heavy demands will naturally be made on the sound damping of the room. At high frequencies, therefore, one will very often notice reflections from the room's walls. These are clearly seen for example on the diagram belonging to fig. 8, particularly for the high frequencies.

As can be seen from the diagram, there is no objection to recording several curves on the same paper, different frequencies often giving an interesting picture of the loudspeaker's behaviour. When one has a sufficient collection of directional curves recorded at different frequencies the frequency characteristic for the different directions can then be deduced. On the diagram paper the technical explanations which are necessary can be written, as well as the number of the loudspeaker, the date, report number, and other technical explanations.

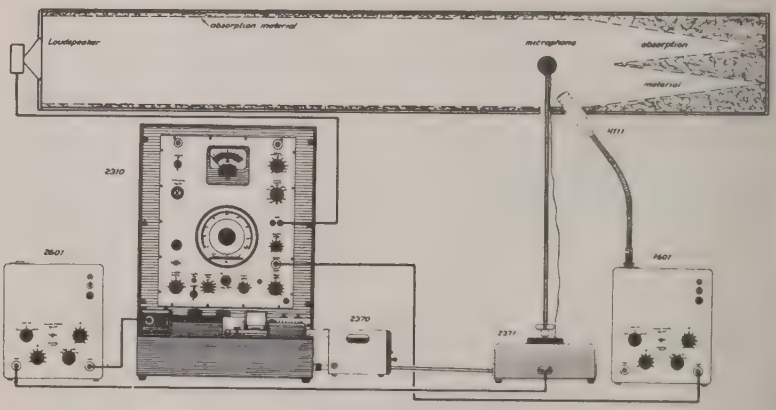


Fig. 9. Recording of directional characteristics of microphones, with example of recording shown on the next page. The compressor is used for producing constant sound pressure when the frequencies are changed.

Fig. 9 shows a typical set-up for the measurement of microphones. Here the loudspeaker is placed within a long tube, which has a very powerfully absorbing tubular section at the end where the microphone is placed; this section absorbs a considerable amount of sound at

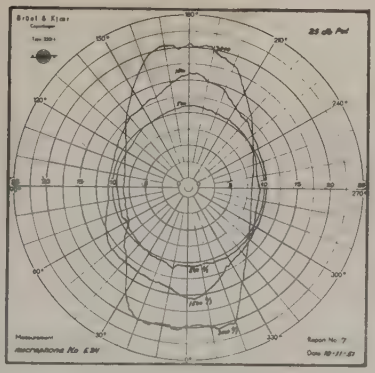


Fig. 9, example of recording.

all frequencies. With such a measuring set-up one can expect that the sound field is relatively homogeneous and that the sound waves are coming from the side only. One should, however, also cover the sides of the tube with some absorbing material, which can absorb the high frequencies which will otherwise be reflected, producing transverse standing waves in the tube. The attached diagram shows some directional curves for a small crystal microphone of the membrane type.

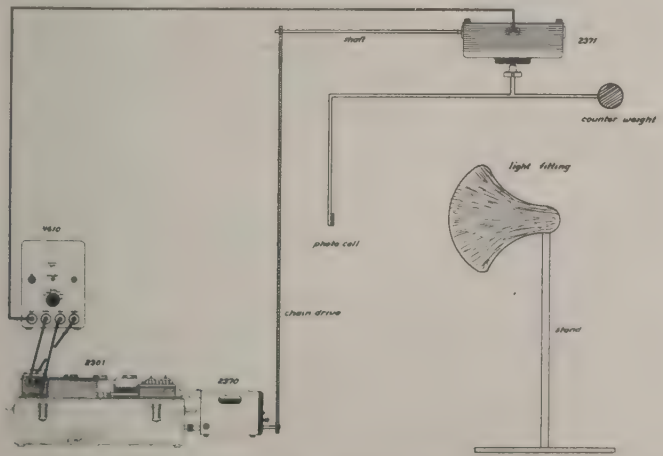


Fig. 10. Recording of directional characteristics of a light beam from a light fitting, with example of recording on the next page. The d.c. voltage from the photo cell is converted to a.c. in the Inverter type 4610 before the recording on 2301.

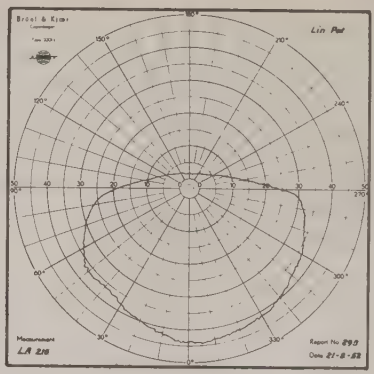
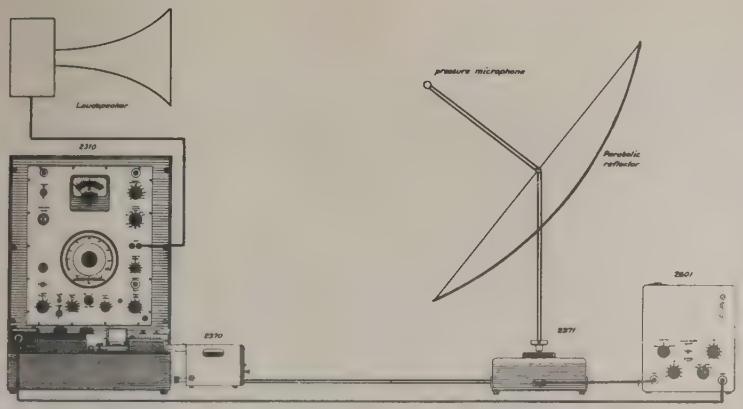


Fig. 10, example of recording.

Fig. 10 shows how the light emission from a light mounting is measured as a function of the angle of rotation, with an example of a recording. As in such cases it is often a question of rather large objects which are difficult to turn in all required directions, the Turntable is attached for this measurement to the ceiling, and on a long rod, which turns round the measuring object, hangs a photo cell which picks up the light. The current from the photo cell, which is proportional to the light intensity, is sent through a resistance whose voltage drop, after having gone through an amplifier, is lead to the Recorder via an Inverter type 4610, which converts the d.c. current to a.c. so that it can be recorded on the Recorder. With these measurements it is a great advantage that the Recorder writes logarithmically, so that a very large range of values can be recorded. This level range can of course be varied by choosing potentiometers from the range 10 db to 75 db. If one desires, the Recorder can also be equipped with a linear potentiometer, which, however, can only write over a range of 10 mV to 110 mV. In the great majority of cases, however, the logarithmic recording will be preferable, as with this a constant relative accuracy is obtained over the whole measuring range.



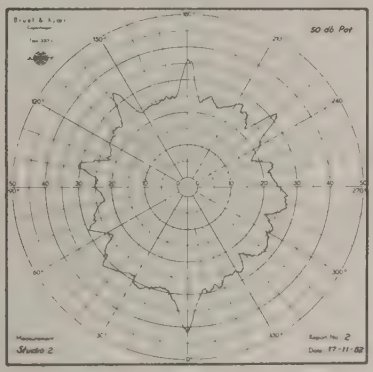
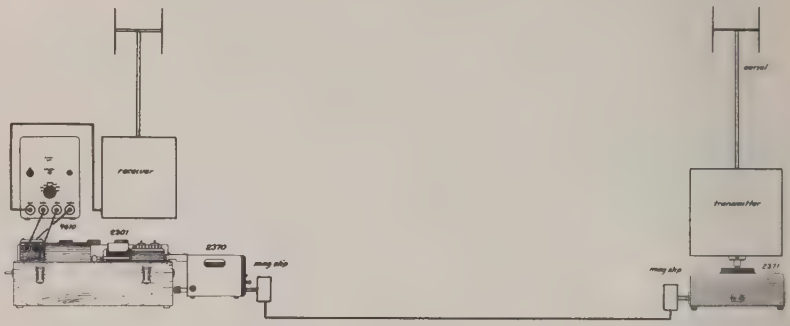


Fig. 11. **Measuring the uniformity of acoustical reflections in concert halls, theatres etc., by scanning all directions with a directional microphone. Example of recording shown.**

Fig. 11 shows how the Polar Diagram Recorder can be used for acoustical measurements in rooms, as first described by professor E. Meyer, Göttingen. Professor Meyer uses an ordinary loudspeaker to supply sound to the room, with a very directionally sensitive microphone which is rotated as shown. A directional diagram of the sound which reaches the directionally sensitive microphone is recorded for various positions. The distribution of sound for bad rooms is very irregular, which is shown on the curve, where the directional

intensity varies very considerably. For a good room these curves are very much smoother. As a directionally effective microphone an ordinary pressure microphone is used placed at the focal point of a parabolic reflector. In order to obtain a powerful directional effect also for relatively low frequencies it is necessary that the reflector be very big, for example with a diameter of from 1-2 m.



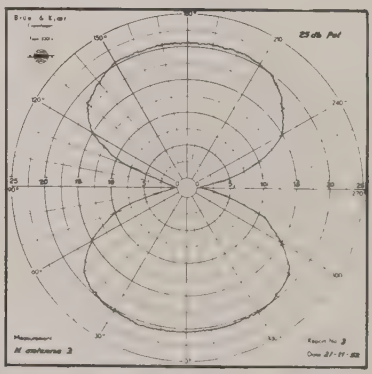


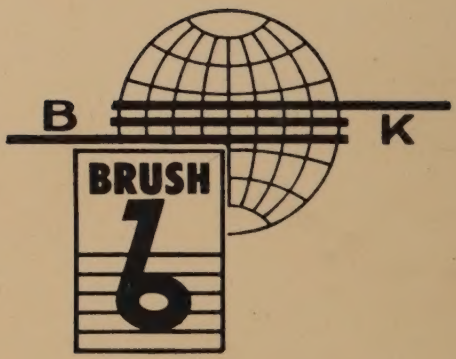
Fig.12. Recording of antenna directional diagrams, with example.

Fig. 12 shows a set-up suitable for measuring the directional effects of antennas. In this case it has been arranged that the transmitting antenna rotates and the receiving antenna is fixed at a considerable distance from the transmitting antenna. It is therefore necessary to have electrical coupling between the Turntable and the Polar Re-

corder. The voltage from the receiving antenna is picked up by a receiver in which the H.F. voltage is rectified, and this rectified voltage goes via an Inverter type 4610 to the Recorder. A condition for this method is that the receiver's signal rectifier works linearly over a level range which is equal to or greater than the greatest level difference in the transmitting antenna's directional diagram.

Parts List for Service

Term	Stock No	Term	Stock No
Lamp housing	JL 3120	Dial lamp	VS 6889
Coaxial socket	JJ 4190	Sapphire writing point	YP 0050
Coaxial plug	JP 4191	Fastening nuts for back plate	YM 0001
Lamp socket	JO 0001	Writing arm with sapphire point	2370186
Switch	NN 0564	Connecting rod for Level Recorder_Polar Recorder	2370191
Magnets	QM 0002	Coupling piece for Level Recorder_Polar Recorder	2370205
Plexiglass plate	SC 2370		
Pivot lamp	VS 1271		
Fastening screws for Level Recorder_Polar Recorder	2370192		



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